Ask Dr. ALOHA:

Gee, why are these footprints so different?

Dateline: Early summer 1996, Watertown, Connecticut...

Al and Bob are firefighters who have become certified ALOHA instructors. They are preparing to put on an ALOHA training course for emergency responders in their fire district. They plan to use ALOHA 5.2—which has just been released—in their course for the first time. They've run several classes like this one, and have developed a set of ALOHA scenarios that they use as class exercises. To prepare for this course, they decide to run their scenarios in ALOHA 5.2. To their surprise, they obtain some results that are very different from the results that they had obtained for the same scenarios using ALOHA 5.1. They find that footprint lengths are much longer for some scenarios, but much shorter for some others. They check their input values carefully to be sure they haven't made any errors, then call CAMEO Technical Support to ask: what's going on? Why are these new results so different?

In fact, two changes have been made to ALOHA 5.2 that can significantly affect the footprint estimates that you will obtain from the model. (ALOHA's footprint is a diagram representing the area within which the ground-level concentration of a pollutant gas is predicted to exceed your Level of Concern (LOC) at some time after a release begins.)

IDLHs have been revised

The Immediately Dangerous to Life or Health (IDLH) level is the default Level of Concern (LOC) in ALOHA. (An LOC is a threshold concentration of an airborne pollutant, usually the concentration above which a hazard may exist.) A chemical's IDLH represents the maximum concentration in the air to which a healthy worker could be exposed for up to 30 minutes without suffering permanent or escape-impairing health effects.

IDLH values have been established for about one-third of the chemicals in ALOHA. IDLHs were first developed in 1974 by the National Institute for Occupational Safety and Health (NIOSH), for selecting respirators for use in workplaces. NIOSH revised and updated all IDLHs in 1994, and these revised values are included in the ALOHA 5.2 chemical library. NIOSH lowered most IDLHs, in some cases to less than 10 percent of the original values. It did not increase any IDLHs. The agency made these changes because more toxicological data are now available, and because new criteria for setting IDLHs have been established. For example, some of the old IDLHs were set equal to the Lower Explosive Limit (LEL) for chemicals known to be explosive, but whose toxic effects have not been characterized (the LEL is the minimum concentration of a chemical in air in which explosion or combustion can occur). Using the new criteria, the new IDLHs for these chemicals have been set equal to 10 percent of the LEL.

Changing IDLH has an important effect on ALOHA's footprint estimates if you're using IDLH as your LOC, because the LOC that you choose has a big effect on footprint size. The lower the LOC, the larger the area within which it may be exceeded, and the larger the footprint. Al and Bob could see the effect of smaller IDLHs in several of their scenarios. For example, they had been using an ethylene dichloride puddle evaporation scenario in their course, and had been using the IDLH of ethylene dichloride as the LOC. The old IDLH for this chemical was 1000 ppm, the value included in the ALOHA 5.1 chemical library. When you use this value as your LOC in ALOHA 5.2, ALOHA predicts that the threat zone for this scenario will be so small (extending about 70 yards downwind from the release point), that it does not draw a footprint diagram. But using the new IDLH of 50 ppm, ALOHA 5.2 predicts that the footprint will extend about 400 yards downwind (Figure 1).

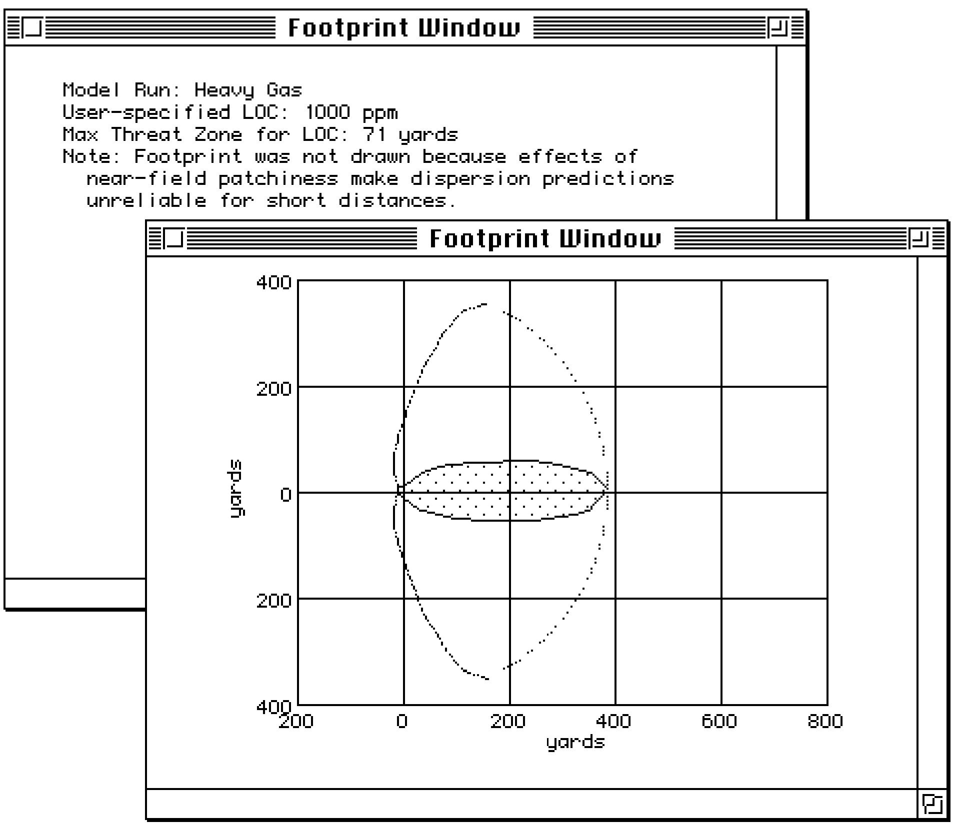

Figure 1. Footprint windows for an ethylene dichloride puddle evaporation scenario. Background: using the old IDLH of 1000 ppm as the LOC. Foreground: using the new IDLH of 50 ppm.

A note about Levels of Concern for hazards analysis
The new IDLHs have been included in ALOHA's chemical library and in CAMEO's RIDS database. However, the U. S. Environmental Protection Agency recommends that when you use the hazard analysis method described in *Technical Guidance for Hazards Analysis*,[1](commonly called the "Green Book") to identify the facilities that pose the greatest risk to your community, you continue to use the Levels of Concern listed in the Technical *Guidance* , although for many chemicals, these values are equal to 1/10 of the old IDLHs.

Heavy gas footprints are no longer screening zones
Pressurized releases are among the most dangerous and common kinds of hazardous chemical accidents. When a pressurized liquid escapes from its container, it forms a cold, dense cloud containing both gas and aerosol (small liquid droplets). This is the kind of release that ALOHA calls a "two-phase flow;" ALOHA usually chooses to model such releases as cases of heavy gas dispersion. Because the chemical is ejected under high pressure, it takes only a short time to empty the container (usually just a few seconds to a few minutes, depending on the container size, hole size, and pressure). The release rate starts out high, then drops off quickly as the container pressure drops.

ALOHA's heavy gas dispersion calculations are much more complicated than the computations it makes to model dispersion of "neutrally buoyant" gases (gases that are no more dense or heavy than air), and take longer to complete. ALOHA 5.1 makes some important simplifications in order to draw heavy gas footprints in the short time available for emergency response. It models a pressurized release by predicting the fastest release rate possible for the scenario (this would be the rate during the first minute or so of the release, when pressure within the container is highest and material is ejected most rapidly), then assuming that high release rate to be maintained indefinitely, in order to complete calculations and display a footprint in a reasonable length of time.

This simplification means that ALOHA 5.1 overpredicts footprint size in pressurized release cases (it alerts you to this with messages in the Footprint and Text Summary windows). ALOHA 5.2, in contrast, does not make this simplification—it can account for changes in release rate and for release duration—so it does not overestimate the size of heavy gas footprints. This change means that ALOHA's accuracy has been improved, and that, for short-duration or pressurized heavy gas releases, ALOHA 5.2 often predicts shorter footprints than ALOHA 5.1 predicts for the same scenario.

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[1]This handbook was prepared by the U. S. Environmental Protection Agency, the Federal Emergency Management Agency, and the U. S. Department of Transportation to provide direction to people required to perform the hazard analyses described in Title III of the Emergency Planning and Community Right-to-Know Act, also known as the Superfund Amendments and Reauthorization Act of 1986 (SARA).

For example, Al and Bob use as a class example a scenario in which the valve stem of a 1-ton chlorine cylinder is knocked off. For this scenario, ALOHA 5.1, using chlorine's new IDLH of 10 ppm, predicts footprint length to be 2 miles. ALOHA 5.2, using the same input values and revised IDLH, predicts the footprint to be only 1.3 miles long (Figure 2).

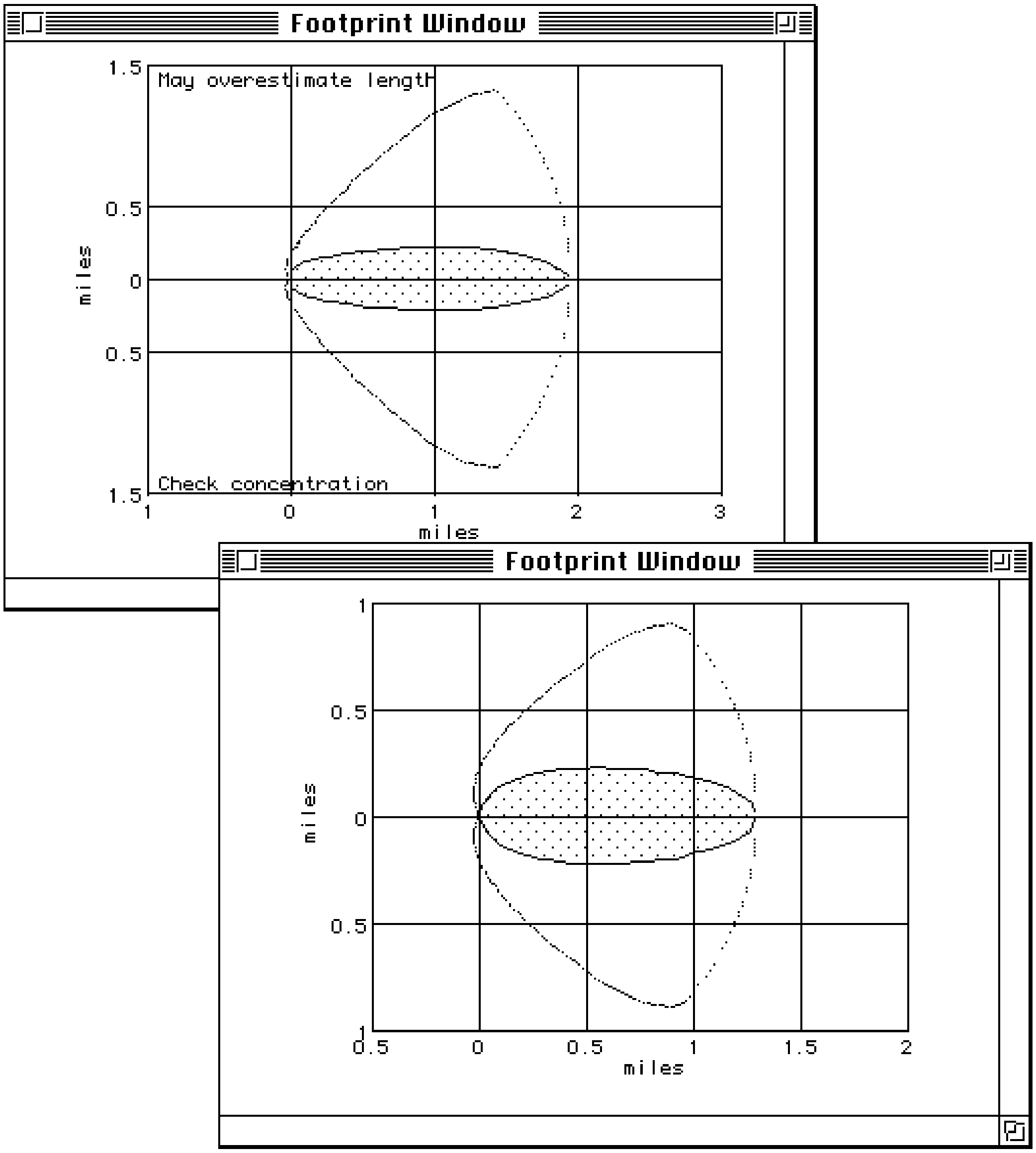

Figure 2. Heavy gas footprints displayed by ALOHA 5.1 (background) and ALOHA 5.2 (foreground) for a release from a 1-ton chlorine cylinder.

Don't be surprised

Users of ALOHA 5.2 are likely to notice the effects of the revised IDLHs and changes to the heavy gas computations (as well as the effects of other changes made to ALOHA). ALOHA's developers believe that these changes represent important improvements to the model. If you have run scenarios in ALOHA for planning purposes, be sure to re-run them in ALOHA 5.2, especially if you have been using IDLHs for your LOCs and if you have been modeling pressurized or short-duration heavy gas release cases.

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A mystery scenario

One of the students in Bob and Al's class is a Hartford firefighter who recently responded to an incident in which formaldehyde was released from a leaking container in an outbuilding at a university research laboratory (the formaldehyde had leaked out onto an asphalt parking lot and formed an evaporating puddle). During a class break, he decides to model that incident in ALOHA. He remembers that at the time of the incident (early afternoon in late April), the wind speed was about 5 knots, under clear skies, and the temperature was about 50°F. He thinks that the puddle was about 100 square feet in area, and perhaps half an inch deep, on average. He enters this information into ALOHA, and is very surprised by the results he obtains. Why is he surprised? Could ALOHA's results be wrong? (Answer in the next issue.)

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